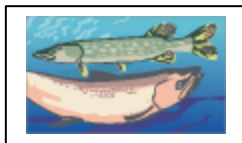

Trends in Great Lakes Fish



2002 SOLEC REPORT: Trends in Contaminant Burdens of Great Lakes Fish (1977 - 2001)

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D.M. Whittle, M.J. Keir, A.A. Carswell

Department of Fisheries & Oceans

Great Lakes Laboratory for Fisheries & Aquatic Sciences

Burlington, ON L7R 4A6

Purpose

Annual analysis of contaminant burdens in representative fish species from throughout the Great Lakes provides data to describe temporal and spatial trends of bioavailable contaminants, which is a measure of both the effectiveness of remedial actions related to the management of critical pollutants and an indicator of emerging problems.

Ecosystem Objective

Great Lakes waters should be free of toxic substances that are harmful to fish and wildlife populations and the consumers of these biota. Data on status and trends of contaminant conditions, using fish as biological indicators, supports the requirements of GLWQA Annex 1 (Specific Objectives), Annex 2 (Lakewide Management Plans/Remedial Action Plans), Annex 11 (Surveillance & Monitoring), and Annex 12 (Persistent Toxic Substances).

State of the Ecosystem

Long-term (>25 yrs), basinwide monitoring programs measuring whole body levels of a variety of contaminants in top predator lake trout or walleye and forage fish species (i.e. smelt) have provided temporal and spatial trend data on bioavailable toxic substances in the Great Lakes aquatic ecosystem. Since the late 1970's levels of historically regulated contaminants such as PCBs, DDT, and mercury have generally declined in most fish species monitored. Some other contaminants, both currently regulated and unregulated, have demonstrated either slowing declines, or in some cases, increases in selected fish communities. The changes are often lake specific and relate both to the specific characteristics of the substances involved and to the biological condition of the fish community surveyed.

Trends

Lake Ontario

PCB levels in Lake Ontario lake trout (4+ - 6+ age class) have declined consistently through 2001 (Figure 9-F1). Similarly S DDT levels have also steadily declined in this same cohort of fish from the most recent peak measured in 1994 (Figure 9-F2). Levels of both PCBs and S DDT in smelt samples have declined significantly through 2001 since the most recent peak in 1997 (Figures 9-F3 & 9-F4). Concentrations of mercury in smelt populations have remained virtually unchanged since 1985 (Figure 9-F5).

Lake Erie

PCB levels in Lake Erie lake trout (4+ - 6+ age class) have declined consistently, with levels measured in 2001 approximately 16 percent of those concentrations found in the same age class from 1993 (Figure 9-F1). Modest increases in S DDT levels were observed in 2001 lake trout samples (4+ - 6+) (Figure 9-F2). PCB concentrations in walleye (4+ - 6+) have continued to increase over the period 1995 to 2001, but recent levels are still ~ 60 percent of those measured in similarly aged fish in 1992 (Figure 9-F6). In 2001, S DDT levels in samples of walleye (4+ - 6+) were 15 percent of maximum levels recorded in 1989, soon after the arrival of zebra mussels in Lake Erie (Figure 9-F7). Total PCB and S DDT levels in smelt peaked in 1990 and 1989, respectively (Figures 9-F3 & 9-F4). Since that time, concentrations of both contaminants have steadily declined through 2001. Mercury concentrations in smelt samples have seen a modest increase in the past two years, 2000 and 2001 (Figure 9-F5).

Lake Huron

For both PCBs and S DDT, as measured in Lake Huron lake trout (4+ - 6+ age class), concentrations have declined steadily through 2001 from the most recent peaks measured in 1993 in similarly aged fish (Figures 9-F1 & 9-F2). Similarly, most recent peak concentrations of PCB and S DDT, measured in 1994 and 1993 samples of smelt, were followed by a period of steady decline in concentrations; 2001 levels were the lowest in the past decade (Figures 9-F3 & 9-F4). Mercury levels in Lake Huron smelt populations have remained virtually unchanged since 1985, with 2001 concentrations less than 50 percent of maximum levels measured throughout a 24-year period (Figure 9-F5).

Lake Superior

Total PCB levels measured in a specific lake trout age class (4+ - 6+) have fluctuated significantly over the past six years, but 2001 concentrations were ~ 20 percent of 1993 levels and 10 percent of 1988 maximum concentrations measured in this same age class of fish (Figure 9-F1). S DDT levels for the 4+ - 6+ age class of lake trout have declined relatively constantly to a concentration in 2001 samples which was less than 20 percent of a recent maximum observed in 1993 samples (Figure 9-F2). Apart from an anomalously high peak ($> 1.0 \mu\text{g/g}$) measured in smelt collections from 1988, total PCB levels have remained virtually unchanged through 2000 at levels of near $0.02 \mu\text{g/g}$ (Figure 9-F3). Over the period 1981 to 2000, S DDT concentrations observed in smelt populations have remained unchanged since a significant decline occurred in

1984 (Figure 9-F4). An exception was a single-year modest increase seen in 1998 samples. Mercury concentrations in Lake Superior smelt populations have exhibited a reasonably steady decline over the period 1981 through 1999 (Figure 9-F5). There was a six-year period, from 1988 through 1993, of increasing concentrations of mercury, but levels measured from 1995 through 1999 were consistently lower.

Toxaphene levels measured in the Lake Superior lake trout community have either increased slightly or ceased to decline despite the fact that use of the compound has either been banned or severely restricted within the Great Lakes Basin since the early 1980's (Whittle et al., 2000). Evidence suggests that declines in the abundance of smelt populations, subsequent diet shifts by lake trout to more contaminated lake herring, and the increase in atmospheric deposition may have accounted for the trend in toxaphene burdens measured in Lake Superior.

Similarly, in Lake Erie after the late 1980's invasion and proliferation of zebra and quagga mussels, contaminant levels measured in top predator walleye did increase for a short period of time. The influence of exotic dreissenid invaders such as zebra and quagga mussels, round gobys, Eurasian ruffe, or invertebrate species such *Echinogammarus* or *Cercopagis* is to change the form and function of existing food webs (Morrison et al., 1998, 2002). This change alters the food web energy dynamics as well as the pathways and fate of contaminants, which in turn can result in shifts in bioaccumulation patterns.

Future Pressures

Probably one of the most immediate pressures impacting contaminant dynamics in the Great Lakes relates to the increasing proliferation of exotic nuisance species. Their increasing presence has altered both fish community composition and food web energy flows. Thus, subsequent changes to the pathways and fate of contaminants have resulted in altered bioaccumulation rates in portions of fish communities, as evidenced by recent spikes in contaminant burdens. Alterations to the forage base of fish communities have resulted in diet shifts and, in some cases, the consumption of a more contaminated prey, which produces elevated body burdens of contaminants. Other pressures relate to the issue of climate change, which includes a warming trend. This change in the thermal regime of the Great Lakes will directly influence the thermodynamics of contaminants and alter bioaccumulation rates. Associated changes in water levels, critical habitat availability, and aquatic ecosystem reproductive success will all be future factors influencing contaminant trends in the Great Lakes.

Further Work Necessary

Future contaminant monitoring studies focusing on the Great Lakes should include more detailed examination of contaminant levels and dynamics in aquatic food webs. These data could be utilized to further develop predictive models to understand the potential changes to contaminant fate and pathways, together with alterations in energy flow. If there is a more complete comprehension of possible future scenarios related to changes in environmental conditions and contaminant impacts, there is the potential to develop compensatory management strategies for both remediation of contaminated ecosystems and utilization of existing fish stocks for recreational and commercial harvest.

References

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Morrison, H.A., Whittle, D.M., Haffner, G.D. 2000. The Relative Importance of Species Invasions and Sediment Disturbance in Regulating Chemical Dynamics in Western Lake Erie. *Ecological Modelling* 125:279-294.

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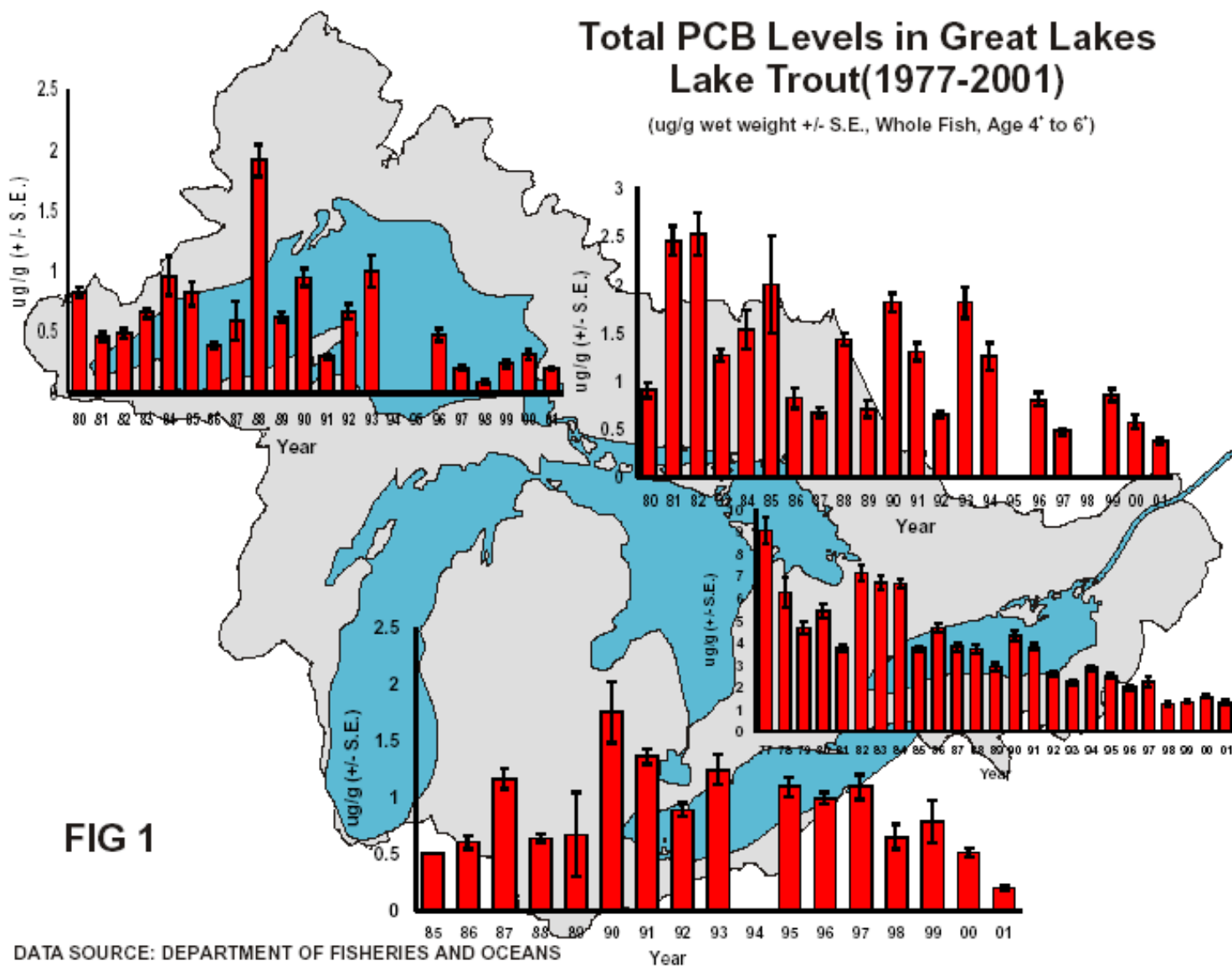


Figure 9-F1. Total PCB Levels in Great Lakes Lake Trout (1977-2001)

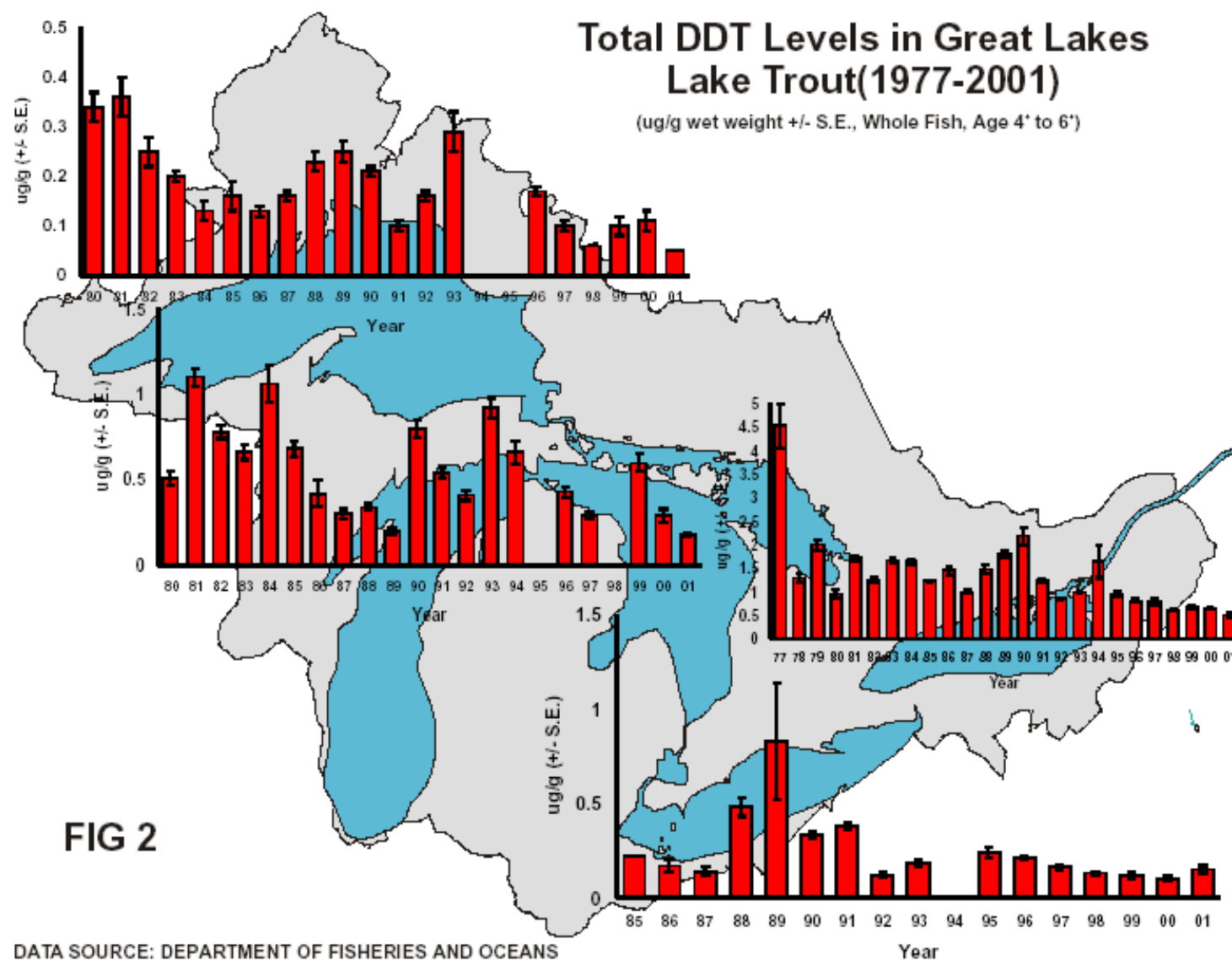


Figure 9-F2. Total DDT Levels in Great Lakes Lake Trout (1977-2001)

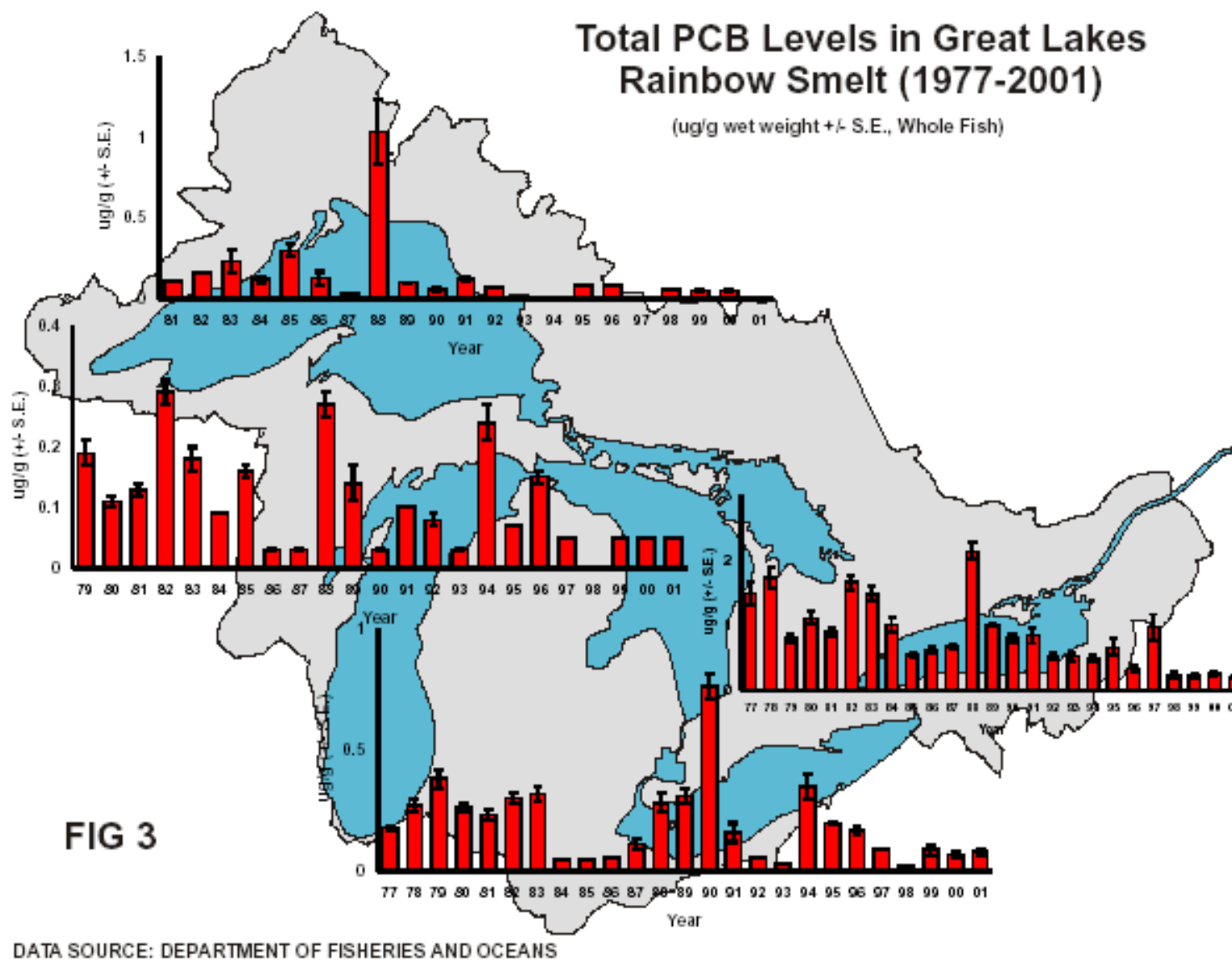


Figure 9-F3. Total PCB Levels in Great Lakes Rainbow Smelt (1977-2001)

Total DDT Levels in Great Lakes Rainbow Smelt (1977-2001)

(ug/g wet weight \pm S.E., Whole Fish)

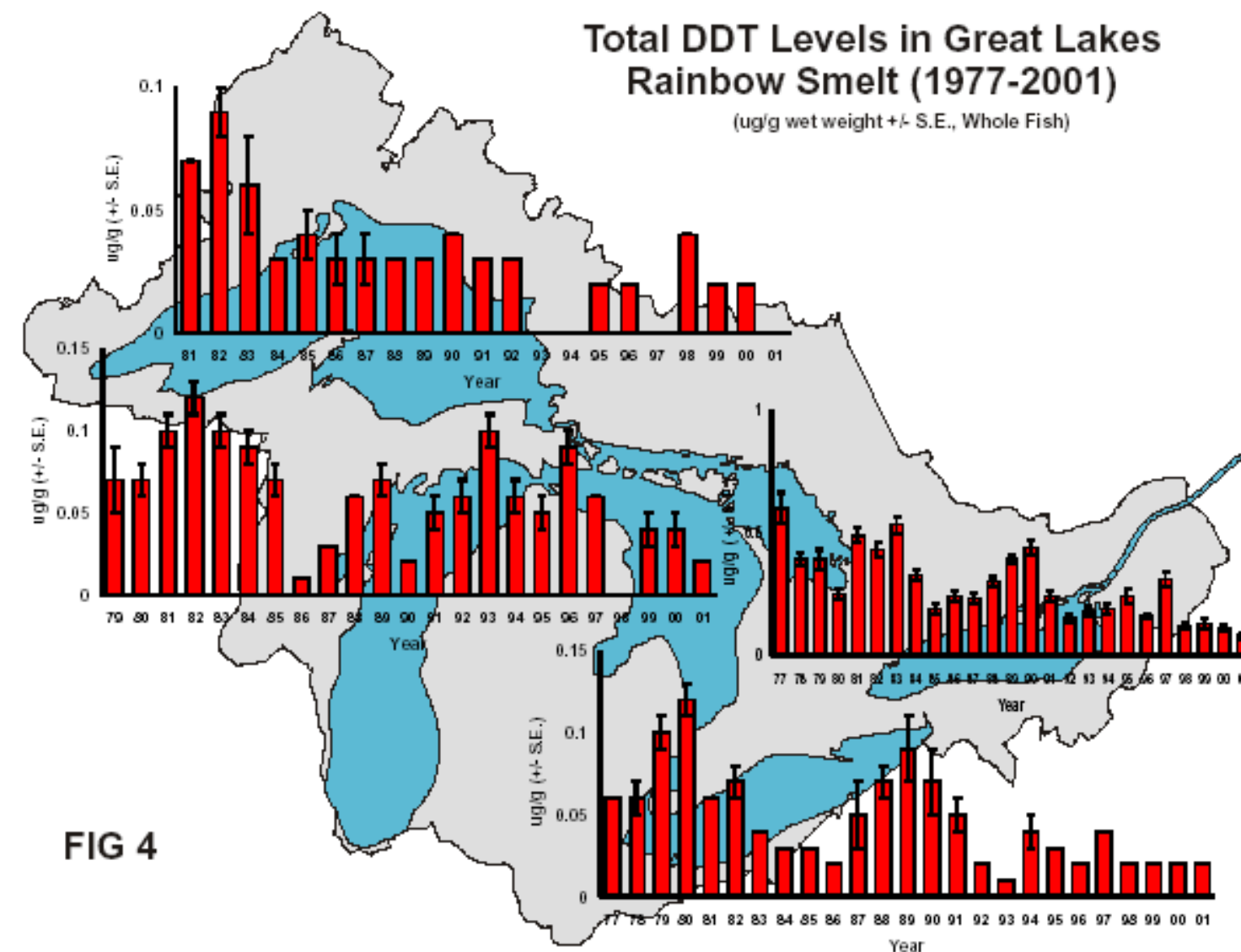


Figure 9-F4. Total DDT Levels in Great Lakes Rainbow Smelt (1977-2001)

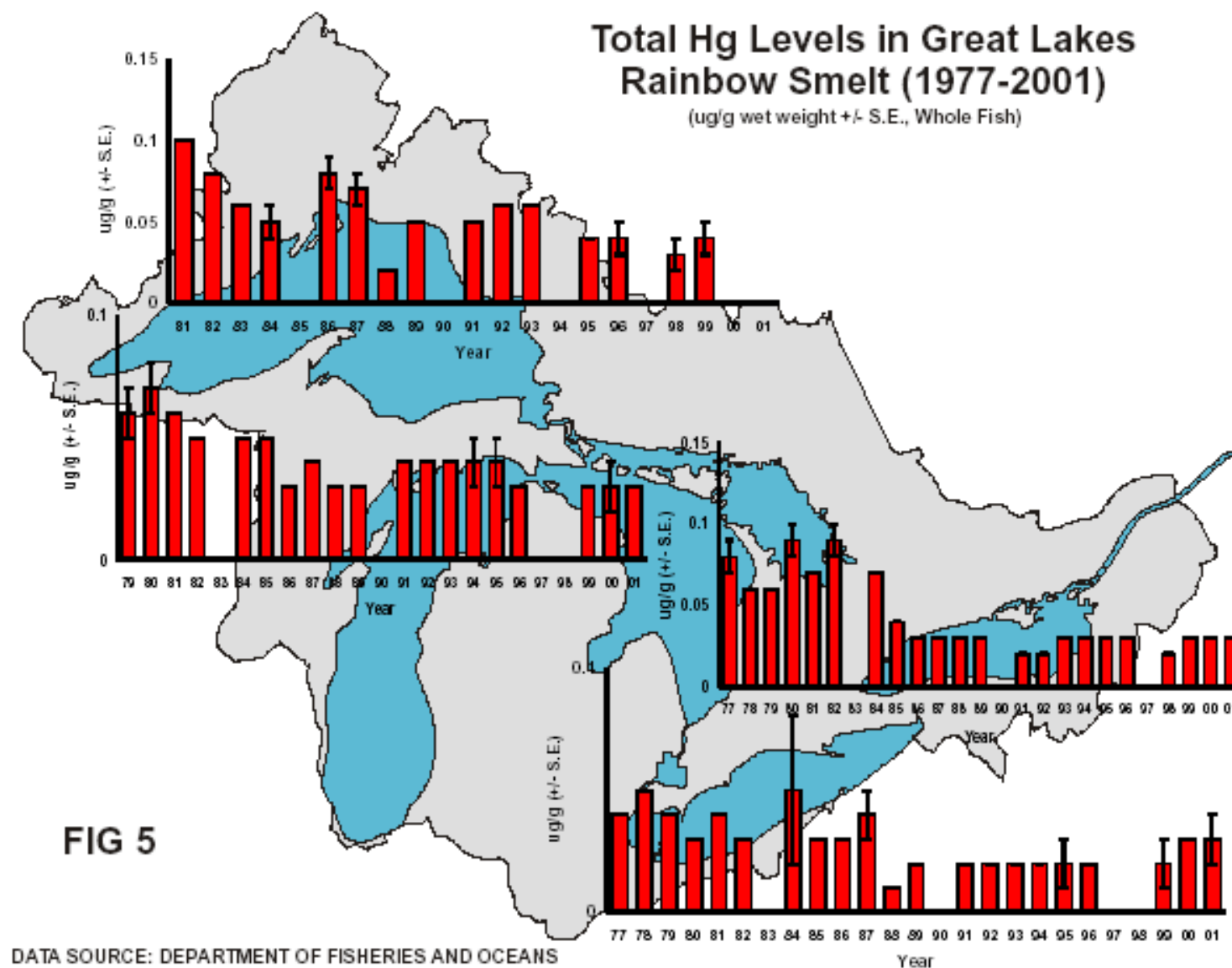


Figure 9-F5. Total Mercury Levels in Great Lakes Rainbow Smelt (1977-2001)

Total PCB Levels in Lake Erie Walleye (1977-2001)

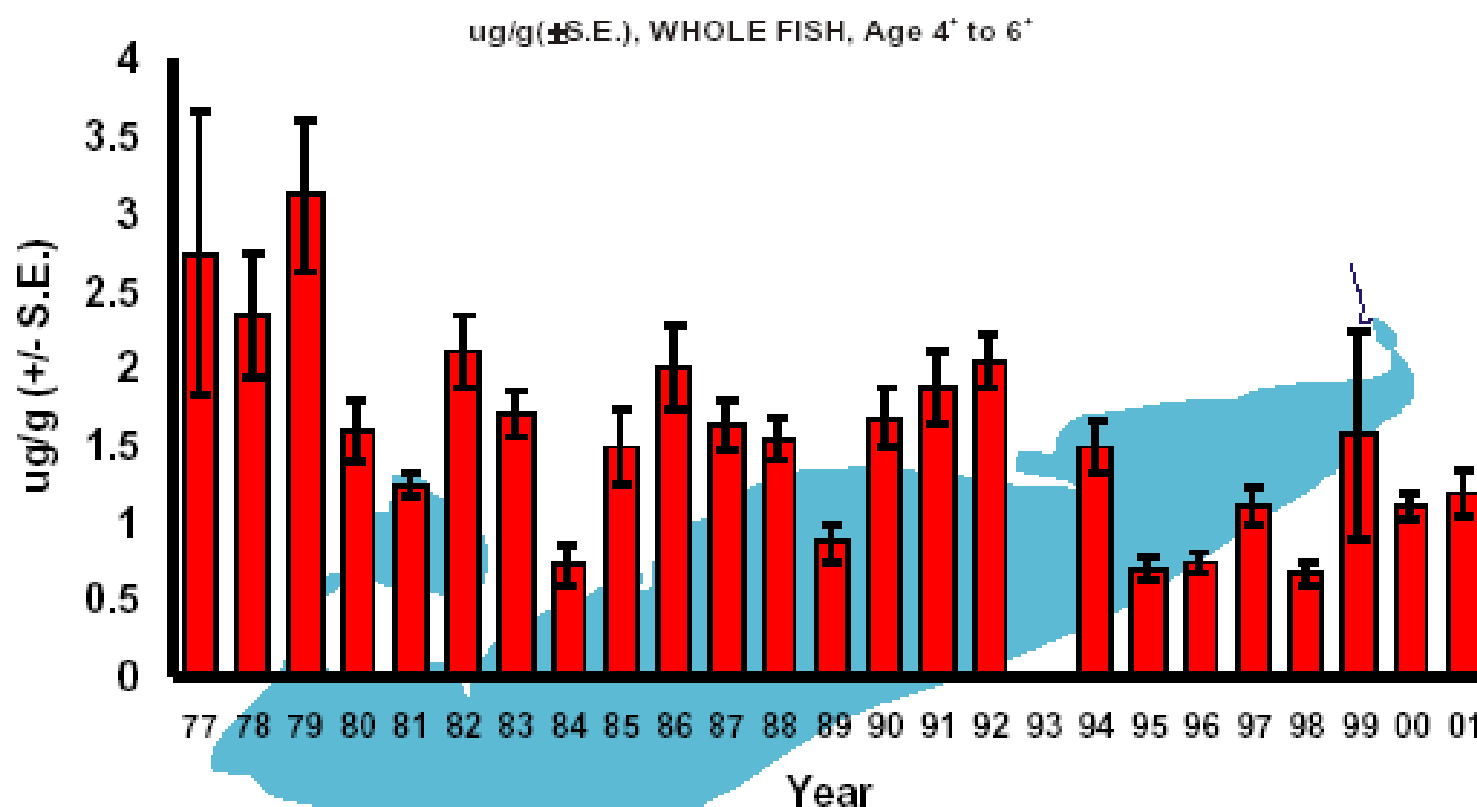


FIG 6

Figure 9-F6. Total PCB Levels in Lake Erie Walleye (1977-2001)

Total DDT Levels in Lake Erie Walleye (1977-2001)

ug/g(\pm S.E.), WHOLE FISH, Age 4+ to 6+

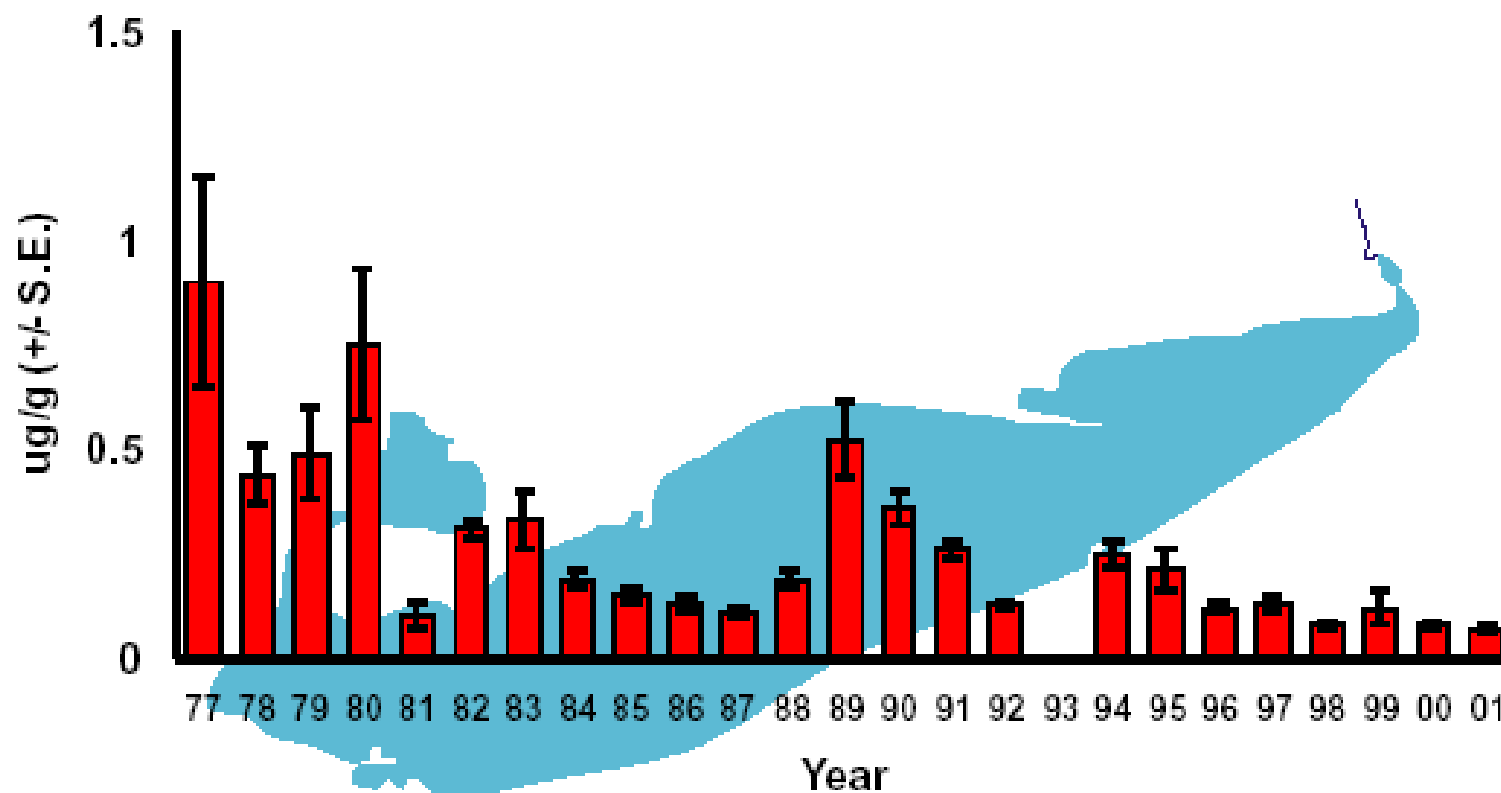


FIG 7

Figure 9-F7. Total DDT Levels in Lake Erie Walleye (1977-2001)

Great Lakes Fish Monitoring Program

Sandy Hellman

Great Lakes National Program Office

U.S. Environmental Protection Agency

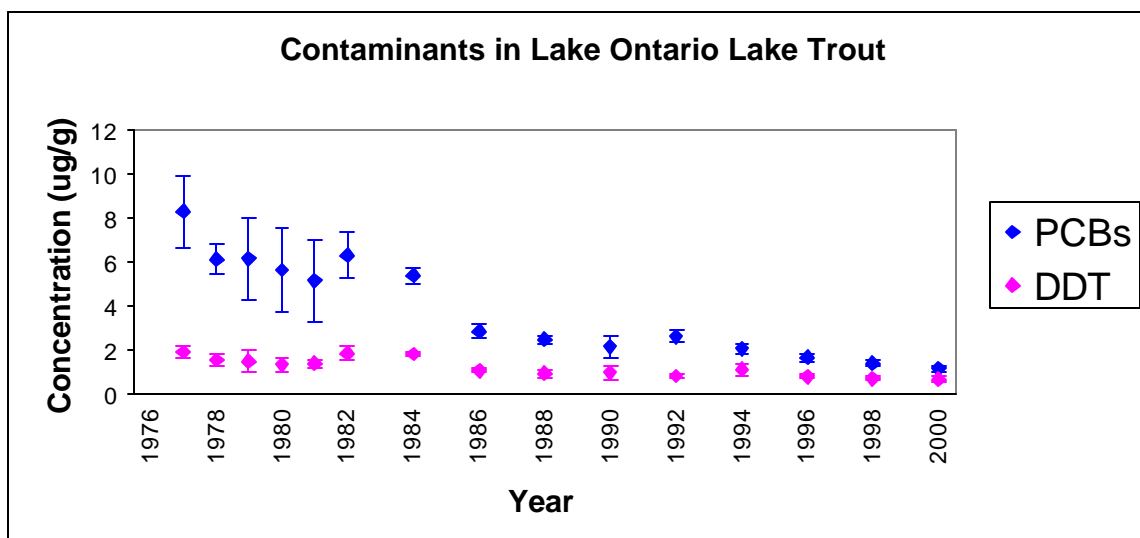
Background

The Great Lakes Fish Monitoring Program (GLFMP) has been monitoring the presence of toxic contaminants in fish since the 1970's. The measurement of whole body levels of contaminants in top predator fish has provided temporal and spatial trend data on bioavailable toxic substances in the Great Lakes ecosystem. The GLFMP is a cooperative program involving the U.S. Fish and Wildlife Service (currently the U.S. Geological Survey-Great Lakes Science Center), the U.S. Food and Drug Administration (no longer participating), the eight Great Lakes states, and the Great Lakes National Program Office, U.S. Environmental Protection Agency.

Trends

The following graphs show PCB and S DDT (total DDT) trends for whole fish lake trout (walleye in Lake Erie) in each of the Great Lakes. Fish samples are collected in the fall of the year and then composited into five fish composites, using fish of similar size to reduce the impact of size variation on contaminant trend data. The data are reported in units of microgram per gram (ug/g) wet weight with a +/- 95 percent confidence interval (C.I.).

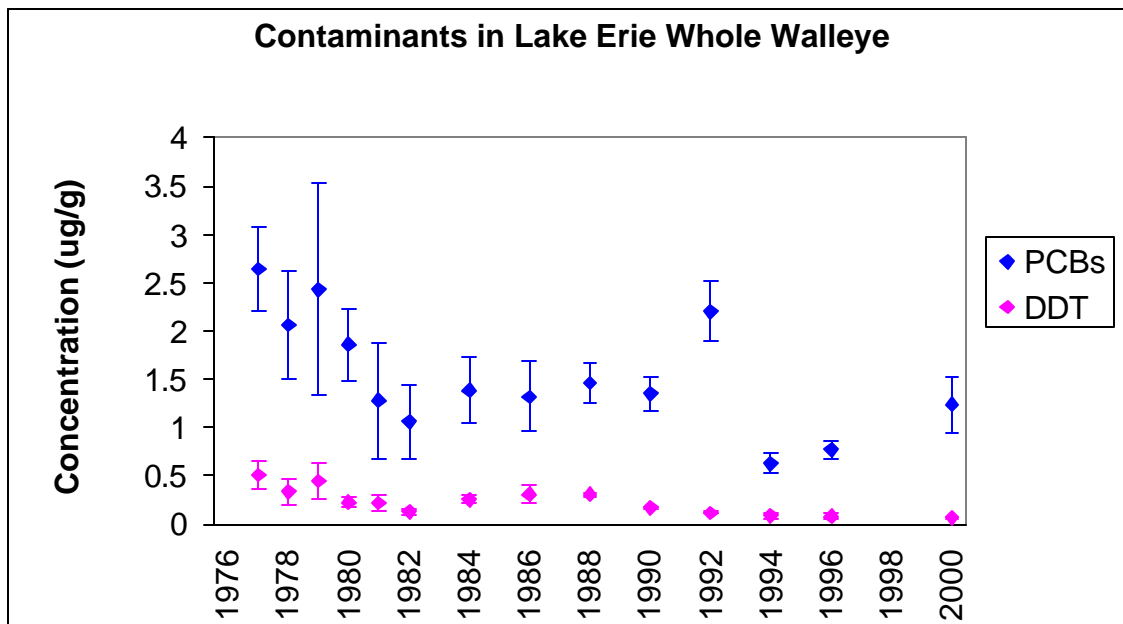
Lake Ontario



PCB and S DDT data: ug/g wet weight +/- 95 percent C.I., whole fish, composite samples, 600-700 mm size range

In Lake Ontario, PCB and S DDT levels in lake trout have declined consistently through 2000. PCB levels in 2000 lake trout are approximately 21 percent of those found in 1977. Current S DDT levels are approximately 37 percent of concentrations found in lake trout in 1977.

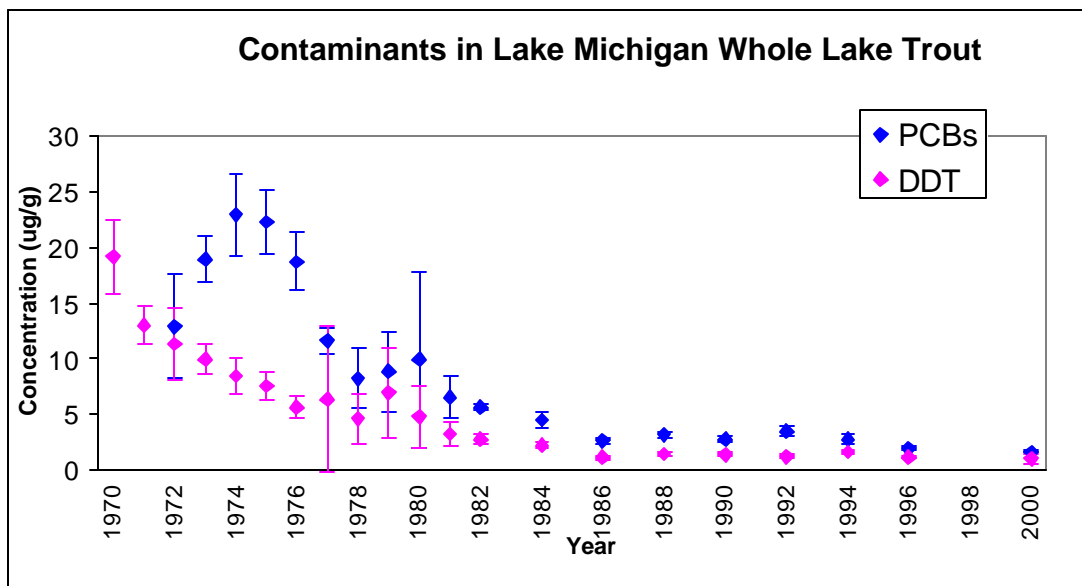
Lake Erie



PCB and SDDT data: ug/g wet weight +/- 95 percent C.I., whole fish, composite samples, 400-500 mm size range

Following initial declines, PCB concentrations in Lake Erie walleye have continued to increase over the period 1995-2000, but recent levels are still ~ 60 percent of those measured in similarly sized fish in 1992. SDDT levels in walleye have declined consistently through time with year 2000 levels approximately 23 percent of levels recorded in 1988.

Lake Michigan

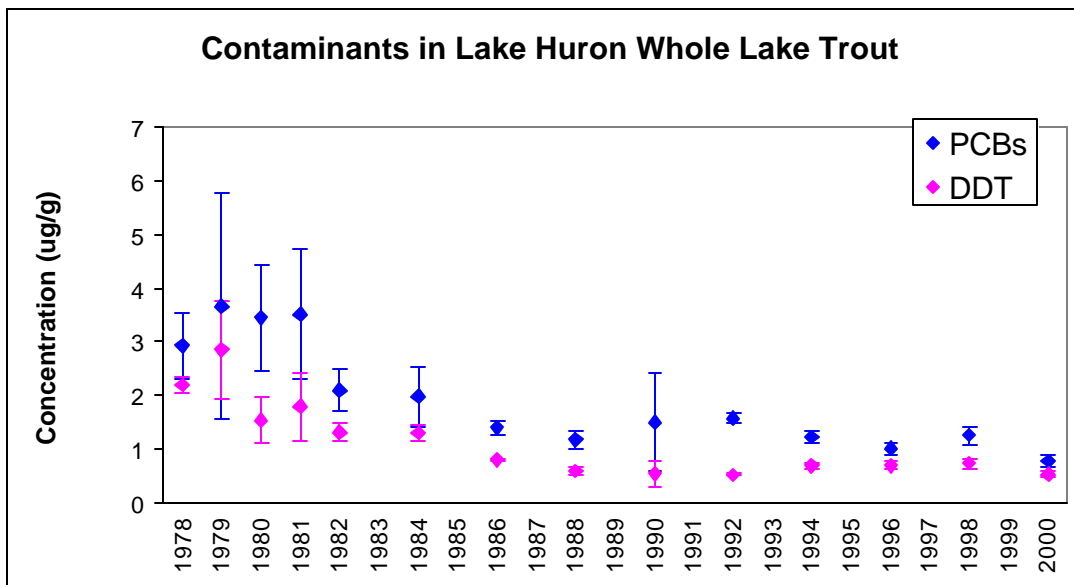


PCB and SDDT data: ug/g wet weight +/- 95 percent C.I., whole fish, composite samples, 600-700 mm size range

PCB and SDDT levels in Lake Michigan lake trout have declined consistently through 2000. PCB levels in 2000 lake trout are approximately 8 percent of those found in 1974. Current

SDDT levels are approximately 5 percent of concentrations found in 1970.

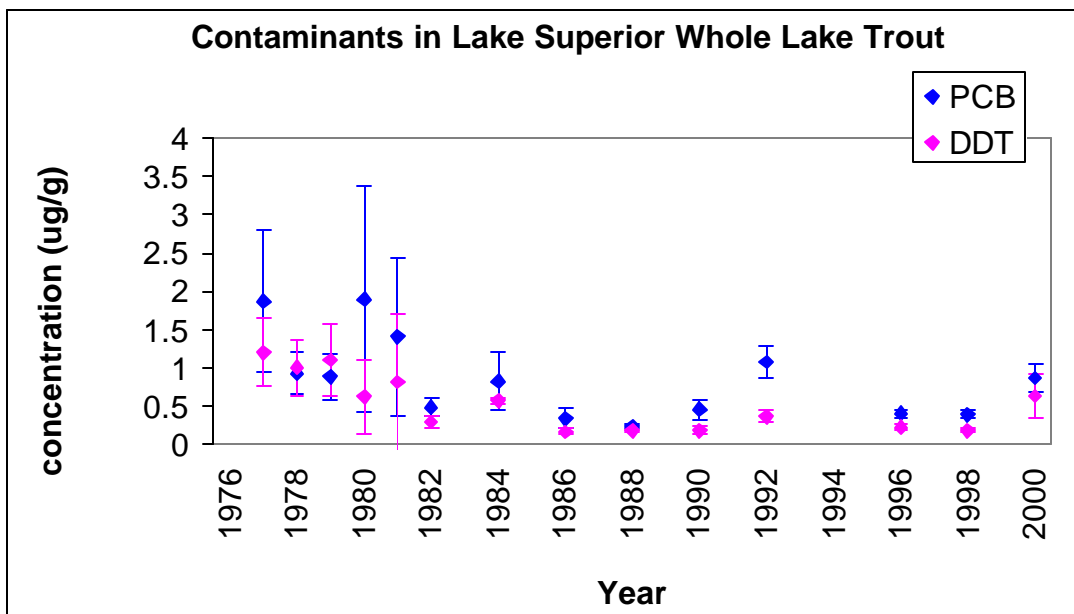
Lake Huron



PCB and SDDT data: ug/g wet weight +/- 95 percent C.I., whole fish, composite samples, 600-700 mm size range

In Lake Huron, PCBs have steadily declined through 2001. SDDT showed large declines in the 1970s and 1980s with levels in the 1990s staying level at concentrations approximately 18 percent of 1979 levels.

Lake Superior



PCB and SDDT data: ug/g wet weight +/- 95 percent C.I., whole fish, composite samples, 600-700 mm size range